

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:
a semiconductor substrate; and
a capacitor provided above the semiconductor
5 substrate,
the capacitor comprising:
a lower electrode containing metal;
a first dielectric film provided above the lower
electrode and containing tantalum oxide or niobium
10 oxide, a top surface of the first dielectric film
including a projecting portion;
an upper electrode provided above the projecting
portion of the first dielectric film and containing
metal;
15 a second dielectric film provided between the
lower electrode and the first dielectric film and
having a lower permittivity than the first dielectric
film; and
a third dielectric film provided between the
20 projecting portion of the first dielectric film and the
upper electrode and having a lower permittivity than
the first dielectric film.
2. The semiconductor device according to claim 1,
wherein the upper electrode, the third dielectric film,
25 and the projecting portion of the first dielectric film
each comprises same shape and same size as viewed from
an upper position.

3. The semiconductor device according to claim 1,
wherein the metal is titanium or tantalum.

4. The semiconductor device according to claim 2,
wherein the metal is titanium or tantalum.

5 5. The semiconductor device according to claim 1,
wherein a material of each of the second and third
dielectric films is at least one of silicon nitride,
aluminum oxide, hafnium oxide, and zirconium oxide.

10 6. The semiconductor device according to claim 2,
wherein a material of each of the second and third
dielectric films is at least one of silicon nitride,
aluminum oxide, hafnium oxide, and zirconium oxide.

15 7. The semiconductor device according to claim 3,
wherein a material of each of the second and third
dielectric films is at least one of silicon nitride,
aluminum oxide, hafnium oxide, and zirconium oxide.

20 8. The semiconductor device according to claim 1,
further comprising a fourth dielectric film provided on
the capacitor and having a lower permittivity than the
first dielectric film.

9. The semiconductor device according to claim 2,
further comprising a fourth dielectric film provided on
the capacitor and having a lower permittivity than the
first dielectric film.

25 10. The semiconductor device according to claim 3,
further comprising a fourth dielectric film provided on
the capacitor and having a lower permittivity than the

first dielectric film.

11. A method of manufacturing a semiconductor device comprising:

preparing a semiconductor substrate;

5 forming a capacitor above the semiconductor substrate, the capacitor comprising a lower electrode containing metal, a multilayer dielectric film, and an upper electrode smaller than the lower electrode and containing metal;

10 forming the capacitor comprising:

forming a first conductive film to be processed into the lower electrode;

forming a first dielectric film containing tantalum oxide or niobium oxide, a second dielectric film, and a third dielectric film, the second dielectric film being formed on the first conductive film, the first dielectric film being formed on the second dielectric film, the third dielectric film being formed on the first film, the second dielectric film and the third dielectric film each having a
15 permittivity lower than the first dielectric film;

20 forming a second conductive film to be processed into the upper electrode on the third dielectric film;

25 etching the second conductive film, and forming the upper electrode;

etching the third dielectric film, and removing a portion of the third dielectric film, the portion

extending outwardly further than a sidewall of the upper electrode; and

etching the first dielectric film, and removing a portion of the first dielectric film, the portion
5 extending from an upper surface of the first dielectric film to a midway depth of the first dielectric film and extending outwardly further than a sidewall of the upper electrode.

12. The method of manufacturing a semiconductor
10 device according to claim 11, wherein each of the second and third dielectric films contains at least one of silicon nitride, aluminum oxide, hafnium oxide, and zirconium oxide as a material.

13. The method of manufacturing a semiconductor
15 device according to claim 11, wherein the metal is titanium or tantalum.

14. The method of manufacturing a semiconductor
device according to claim 12, wherein the metal is titanium or tantalum.

20 15. The method of manufacturing a semiconductor device according to claim 11,

wherein the second conductive film is etched using a fluorine-base gas,

the third dielectric film is etched using a
25 chlorine-based gas, and

the first dielectric film is etched using a mixture gas of a fluorine-base gas and an oxygen gas.

16. The method of manufacturing a semiconductor device according to claim 12,

wherein the second conductive film is etched using a fluorine-base gas,

5 the third dielectric film is etched using a chlorine-based gas, and

the first dielectric film is etched using a mixture gas of a fluorine-base gas and an oxygen gas.

17. The method of manufacturing a semiconductor device according to claim 11, further comprising
10 etching the first dielectric film, the second dielectric film, and the first conductive film and forming the lower electrode.

18. The method of manufacturing a semiconductor device according to claim 12, further comprising
15 etching the first dielectric film, the second dielectric film, and the first conductive film and forming the lower electrode.

19. The method of manufacturing a semiconductor device according to claim 11, further comprising
20 forming a fourth dielectric film having a permittivity lower than the first dielectric film.

20. The method of manufacturing a semiconductor device according to claim 12, further comprising
25 forming a fourth dielectric film having a permittivity lower than the first dielectric film.